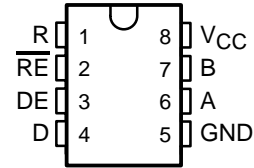


# SN65176B, SN75176B DIFFERENTIAL BUS TRANSCEIVERS

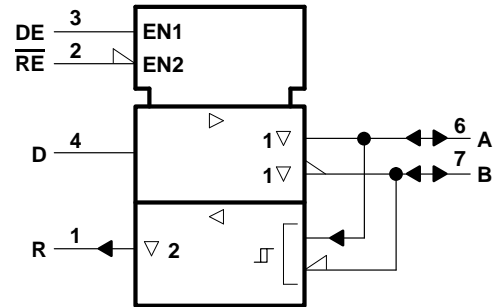
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- Bidirectional Transceivers
- Meet or Exceed the Requirements of ANSI Standards EIA/TIA-422-B and RS-485 and ITU Recommendations V.11 and X.27
- Designed for Multipoint Transmission on Long Bus Lines in Noisy Environments
- 3-State Driver and Receiver Outputs
- Individual Driver and Receiver Enables
- Wide Positive and Negative Input/Output Bus Voltage Ranges
- Driver Output Capability . . .  $\pm 60$  mA Max
- Thermal Shutdown Protection
- Driver Positive and Negative Current Limiting
- Receiver Input Impedance . . . 12 k $\Omega$  Min
- Receiver Input Sensitivity . . .  $\pm 200$  mV
- Receiver Input Hysteresis . . . 50 mV Typ
- Operate From Single 5-V Supply

D OR P PACKAGE  
(TOP VIEW)



## logic symbol†



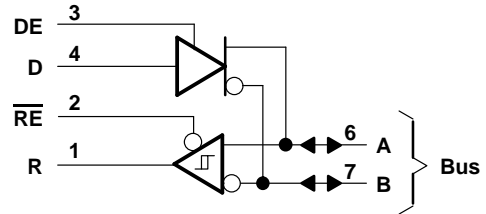
† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

## description

The SN65176B and SN75176B differential bus transceivers are monolithic integrated circuits designed for bidirectional data communication on multipoint bus transmission lines. They are designed for balanced transmission lines and meet ANSI Standards EIA/TIA-422-B and RS-485 and ITU Recommendations V.11 and X.27.

The SN65176B and SN75176B combine a 3-state differential line driver and a differential input line receiver, both of which operate from a single 5-V power supply. The driver and receiver have active-high and active-low enables, respectively, that can be externally connected together to function as a direction control. The driver differential outputs and the receiver differential inputs are connected internally to form differential input/output (I/O) bus ports that are designed to offer minimum loading to the bus whenever the driver is disabled or  $V_{CC} = 0$ . These ports feature wide positive and negative common-mode voltage ranges making the device suitable for party-line applications.

## logic diagram (positive logic)



## Function Tables

DRIVER

INPUT D	ENABLE DE	OUTPUTS	
		A	B
H	H	H	L
L	H	L	H
X	L	Z	Z

RECEIVER

DIFFERENTIAL INPUTS A – B	ENABLE RE	OUTPUT R
$V_{ID} \geq 0.2$ V	L	H
$-0.2$ V < $V_{ID} < 0.2$ V	L	?
$V_{ID} \leq -0.2$ V	L	L
X	H	Z
Open	L	H

H = high level, L = low level, ? = indeterminate, X = irrelevant, Z = high impedance (off)

# SN65176B, SN75176B DIFFERENTIAL BUS TRANSCEIVERS

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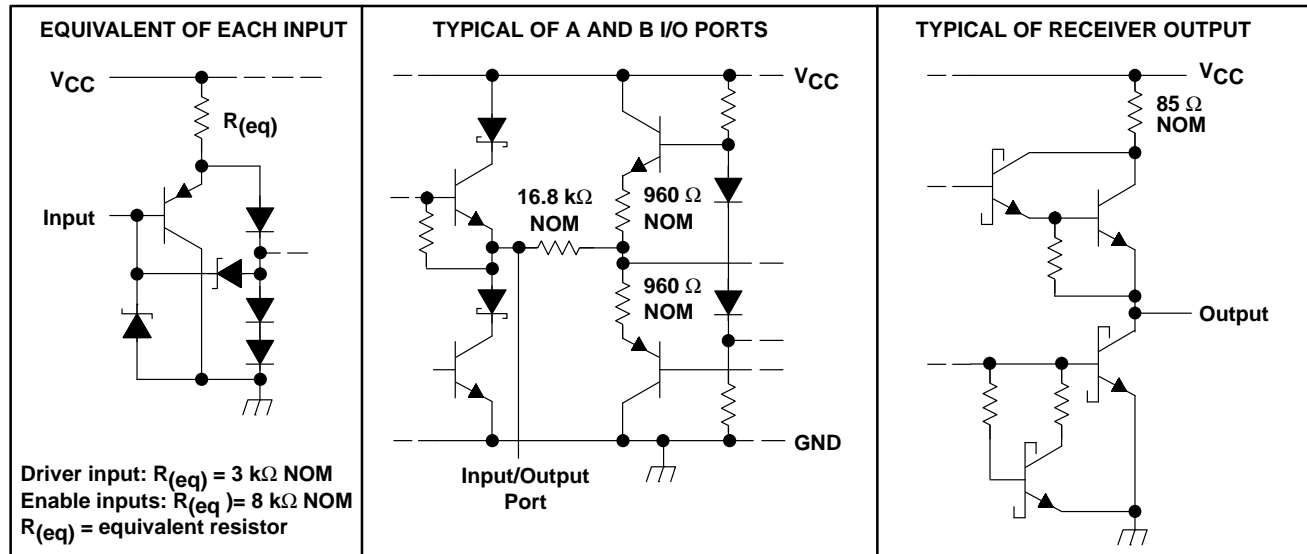
## description (continued)

The driver is designed for up to 60 mA of sink or source current. The driver features positive- and negative-current limiting and thermal shutdown for protection from line-fault conditions. Thermal shutdown is designed to occur at a junction temperature of approximately 150°C. The receiver features a minimum input impedance of 12 kΩ, an input sensitivity of ±200 mV, and a typical input hysteresis of 50 mV.

The SN65176B and SN75176B can be used in transmission line applications employing the SN75172 and SN75174 quadruple differential line drivers and SN75173 and SN75175 quadruple differential line receivers.

The SN65176B is characterized for operation from -40°C to 105°C and the SN75176B is characterized for operation from 0°C to 70°C.

## schematics of inputs and outputs



# SN65176B, SN75176B DIFFERENTIAL BUS TRANSCEIVERS

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## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, $V_{CC}$ (see Note 1) .....	7 V
Voltage range at any bus terminal .....	–10 V to 15 V
Enable input voltage, $V_I$ .....	5.5 V
Continuous total power dissipation .....	See Dissipation Rating Table
Operating free-air temperature range, $T_A$ : SN65176B .....	–40°C to 105°C
SN75176B .....	0°C to 70°C
Storage temperature range, $T_{stg}$ .....	–65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds .....	260°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values, except differential input/output bus voltage, are with respect to network ground terminal.

**DISSIPATION RATING TABLE**

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 105^\circ\text{C}$ POWER RATING
D	725 mW	5.8 mW/°C	464 mW	261 mW
P	1100 mW	8.8 mW/°C	704 mW	396 mW

## recommended operating conditions

		MIN	TYP	MAX	UNIT
Supply voltage, $V_{CC}$		4.75	5	5.25	V
Voltage at any bus terminal (separately or common mode), $V_I$ or $V_{IC}$		12			V
		–7			
High-level input voltage, $V_{IH}$	D, DE, and $\overline{RE}$	2			V
Low-level input voltage, $V_{IL}$	D, DE, and $\overline{RE}$	0.8			V
Differential input voltage, $V_{ID}$ (see Note 2)		$\pm 12$			V
High-level output current, $I_{OH}$	Driver	–60			mA
	Receiver	–400			$\mu\text{A}$
Low-level output current, $I_{OL}$	Driver	60			mA
	Receiver	8			
Operating free-air temperature, $T_A$	SN65176B	–40	105		°C
	SN75176B	0	70		

NOTE 2: Differential-input/output bus voltage is measured at the noninverting terminal A with respect to the inverting terminal B.

# SN65176B, SN75176B DIFFERENTIAL BUS TRANSCEIVERS

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## DRIVER SECTION

electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		MIN	TYP‡	MAX	UNIT
$V_{IK}$	Input clamp voltage	$I_I = -18$ mA				-1.5	V
$V_O$	Output voltage	$I_O = 0$		0		6	V
$ V_{OD1} $	Differential output voltage	$I_O = 0$		1.5	3.6	6	V
$ V_{OD2} $	Differential output voltage	$R_L = 100$ $\Omega$ ,	See Figure 1	$1/2 V_{OD1}$ or 2 $\parallel$			V
		$R_L = 54$ $\Omega$ ,	See Figure 1	1.5	2.5	5	V
$V_{OD3}$	Differential output voltage	See Note 4		1.5		5	V
$\Delta V_{OD} $	Change in magnitude of differential output voltage§	$R_L = 54$ $\Omega$ or 100 $\Omega$ , See Figure 1				$\pm 0.2$	V
$V_{OC}$	Common-mode output voltage					+3 -1	V
$\Delta V_{OC} $	Change in magnitude of common-mode output voltage§					$\pm 0.2$	V
$I_O$	Output current	Output disabled, See Note 3	$V_O = 12$ V			1	mA
			$V_O = -7$ V			-0.8	
$I_{IH}$	High-level input current	$V_I = 2.4$ V				20	$\mu$ A
$I_{IL}$	Low-level input current	$V_I = 0.4$ V				-400	$\mu$ A
$I_{OS}$	Short-circuit output current	$V_O = -7$ V				-250	mA
		$V_O = 0$				150	
		$V_O = V_{CC}$				250	
		$V_O = 12$ V				250	
$I_{CC}$	Supply current (total package)	No load	Outputs enabled		42	70	mA
			Outputs disabled		26	35	

† The power-off measurement in ANSI Standard EIA/TIA-422-B applies to disabled outputs only and is not applied to combined inputs and outputs.

‡ All typical values are at  $V_{CC} = 5$  V and  $T_A = 25^\circ\text{C}$ .

§  $\Delta|V_{OD}|$  and  $\Delta|V_{OC}|$  are the changes in magnitude of  $V_{OD}$  and  $V_{OC}$ , respectively, that occur when the input is changed from a high level to a low level.

$\parallel$  The minimum  $V_{OD2}$  with a 100- $\Omega$  load is either  $1/2 V_{OD1}$  or 2 V, whichever is greater.

NOTES: 3. See ANSI Standard RS-485 Figure 3.5, Test Termination Measurement 2.

4. This applies for both power on and off; refer to ANSI Standard RS-485 for exact conditions. The EIA/TIA-422-B limit does not apply for a combined driver and receiver terminal.

switching characteristics,  $V_{CC} = 5$  V,  $R_L = 110$  k $\Omega$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$t_d(\text{OD})$	Differential-output delay time	$R_L = 54$ $\Omega$ ,	See Figure 3		15	22	ns
$t_t(\text{OD})$	Differential-output transition time				20	30	ns
$t_{PZH}$	Output enable time to high level	See Figure 4			85	120	ns
$t_{PZL}$	Output enable time to low level	See Figure 5			40	60	ns
$t_{PHZ}$	Output disable time from high level	See Figure 4			150	250	ns
$t_{PLZ}$	Output disable time from low level	See Figure 5			20	30	ns



**SYMBOL EQUIVALENTS**

DATA SHEET PARAMETER	EIA/TIA-422-B	RS-485
$V_O$	$V_{oa}, V_{ob}$	$V_{oa}, V_{ob}$
$ V_{OD1} $	$V_o$	$V_o$
$ V_{OD2} $	$V_t (R_L = 100 \Omega)$	$V_t (R_L = 54 \Omega)$
$ V_{OD3} $		$V_t$ (Test Termination Measurement 2)
$\Delta V_{OD} $	$   V_t  -  \bar{V}_t   $	$   V_t  -  \bar{V}_t   $
$V_{OC}$	$ V_{os} $	$ V_{os} $
$\Delta V_{OC} $	$ V_{os} - \bar{V}_{os} $	$ V_{os} - \bar{V}_{os} $
$I_{OS}$	$ I_{sa} ,  I_{sb} $	
$I_O$	$ I_{xa} ,  I_{xb} $	$I_{ia}, I_{ib}$

**RECEIVER SECTION**

**electrical characteristics over recommended ranges of common-mode input voltage, supply voltage, and operating free-air temperature (unless otherwise noted)**

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
$V_{IT+}$	Positive-going input threshold voltage	$V_O = 2.7 V,$	$I_O = -0.4 mA$			0.2	V
$V_{IT-}$	Negative-going input threshold voltage	$V_O = 0.5 V,$	$I_O = 8 mA$	-0.2‡			V
$V_{hys}$	Input hysteresis voltage ( $V_{IT+} - V_{IT-}$ )				50		mV
$V_{IK}$	Enable Input clamp voltage	$I_I = -18 mA$				-1.5	V
$V_{OH}$	High-level output voltage	$V_{ID} = 200 mV,$ See Figure 2	$I_{OH} = -400 \mu A,$		2.7		V
$V_{OL}$	Low-level output voltage	$V_{ID} = -200 mV,$ See Figure 2	$I_{OL} = 8 mA,$			0.45	V
$I_{OZ}$	High-impedance-state output current	$V_O = 0.4 V$ to $2.4 V$				$\pm 20$	$\mu A$
$I_I$	Line input current	Other input = 0 V, See Note 5	$V_I = 12 V$			1	mA
			$V_I = -7 V$			-0.8	
$I_{IH}$	High-level enable input current	$V_{IH} = 2.7 V$				20	$\mu A$
$I_{IL}$	Low-level enable input current	$V_{IL} = 0.4 V$				-100	$\mu A$
$r_I$	Input resistance	$V_I = 12 V$			12		k $\Omega$
$I_{OS}$	Short-circuit output current			-15		-85	mA
$I_{CC}$	Supply current (total package)	No load	Outputs enabled		42	55	mA
			Outputs disabled		26	35	

† All typical values are at  $V_{CC} = 5 V, T_A = 25^\circ C$ .

‡ The algebraic convention, in which the less-positive (more-negative) limit is designated minimum, is used in this data sheet for common-mode input voltage and threshold voltage levels only.

NOTE 5: This applies for both power on and power off. Refer to EIA Standard RS-485 for exact conditions.

# SN65176B, SN75176B DIFFERENTIAL BUS TRANSCEIVERS

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switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $C_L = 15\text{ pF}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t <sub>PLH</sub>	Propagation delay time, low- to high-level output	V <sub>ID</sub> = 0 to 3 V, See Figure 6		21	35	ns
t <sub>PHL</sub>	Propagation delay time, high- to low-level output			23	35	ns
t <sub>PZH</sub>	Output enable time to high level	See Figure 7		10	20	ns
t <sub>PZL</sub>	Output enable time to low level			12	20	ns
t <sub>PHZ</sub>	Output disable time from high level	See Figure 7		20	35	ns
t <sub>PLZ</sub>	Output disable time from low level			17	25	ns

## PARAMETER MEASUREMENT INFORMATION

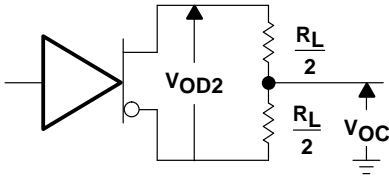


Figure 1. Driver  $V_{OD}$  and  $V_{OC}$

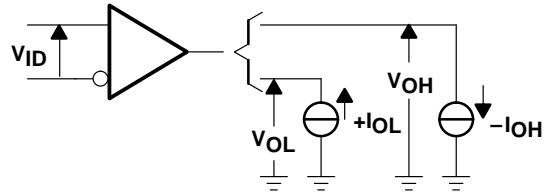
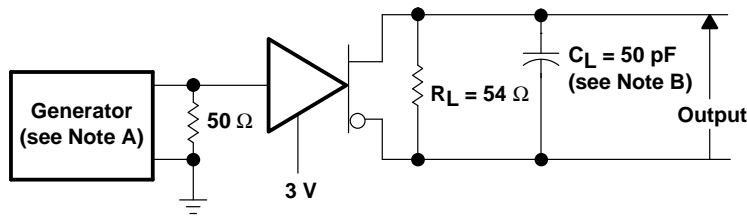
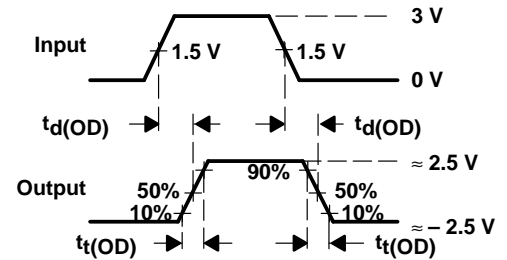


Figure 2. Receiver  $V_{OH}$  and  $V_{OL}$

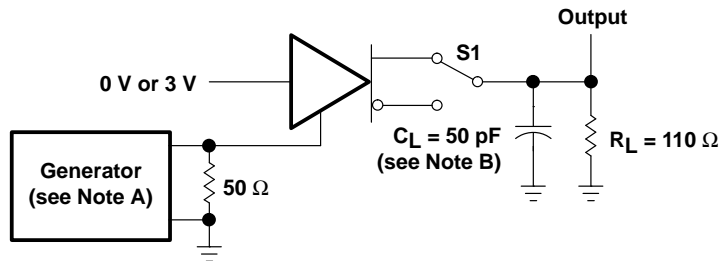


TEST CIRCUIT

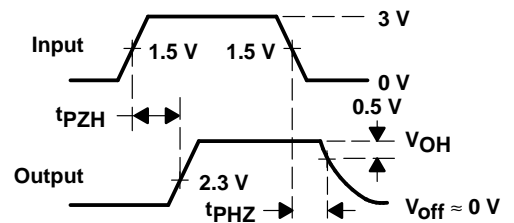


VOLTAGE WAVEFORMS

Figure 3. Driver Test Circuit and Voltage Waveforms

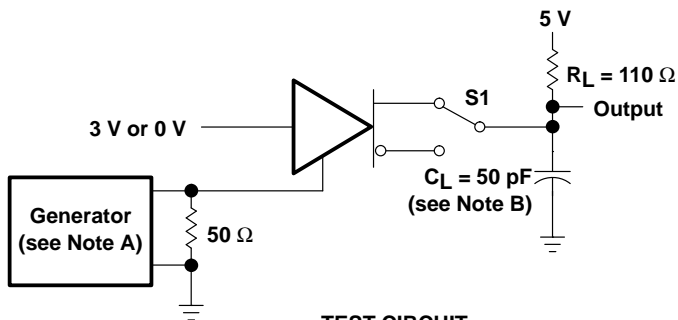


TEST CIRCUIT

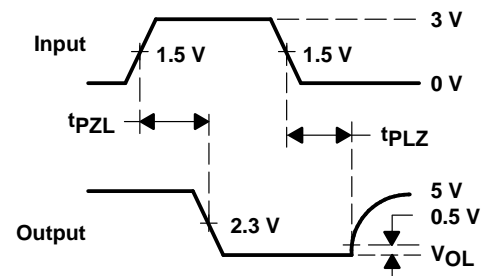


VOLTAGE WAVEFORMS

Figure 4. Driver Test Circuit and Voltage Waveforms



TEST CIRCUIT



VOLTAGE WAVEFORMS

Figure 5. Driver Test Circuit and Voltage Waveforms

- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1$  MHz, 50% duty cycle,  $t_r \leq 6$  ns,  $t_f \leq 6$  ns,  $Z_O = 50 \Omega$ .  
B.  $C_L$  includes probe and jig capacitance.

# SN65176B, SN75176B DIFFERENTIAL BUS TRANSCEIVERS

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## PARAMETER MEASUREMENT INFORMATION

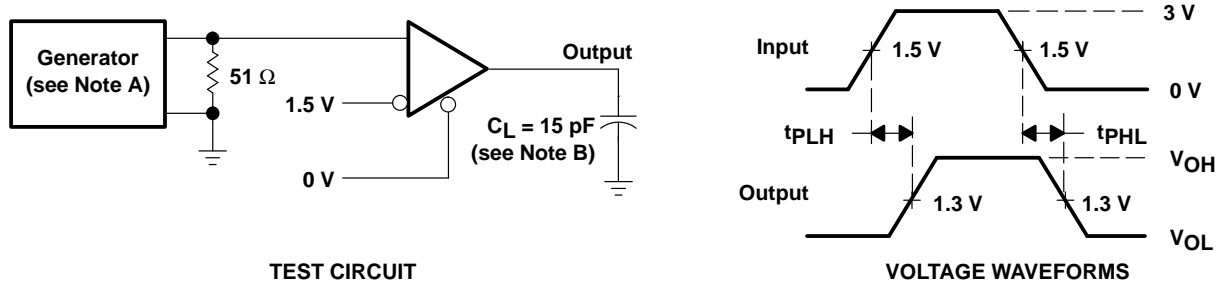


Figure 6. Receiver Test Circuit and Voltage Waveforms

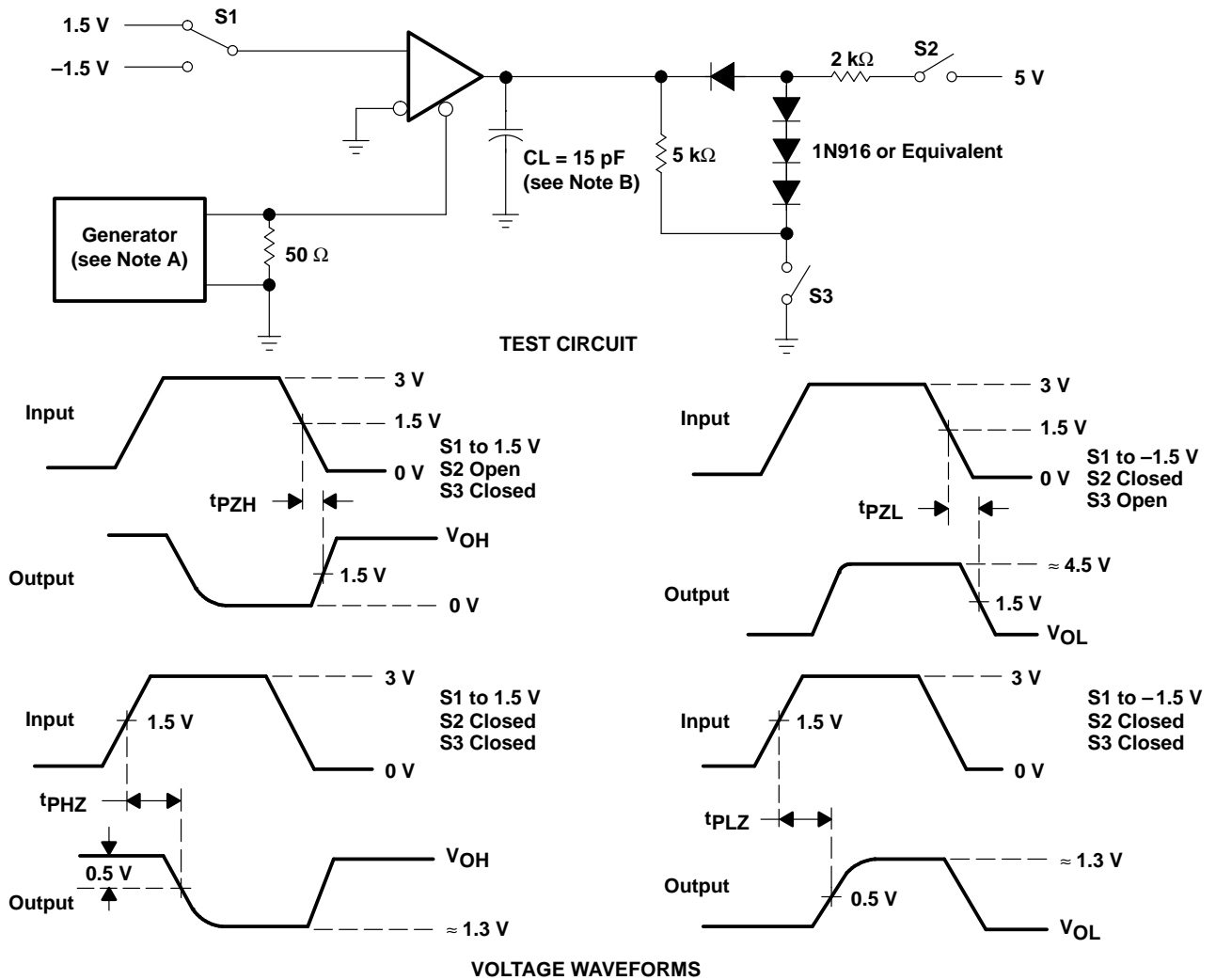


Figure 7. Receiver Test Circuit and Voltage Waveforms

- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1 \text{ MHz}$ , 50% duty cycle,  $t_r \leq 6 \text{ ns}$ ,  $t_f \leq 6 \text{ ns}$ ,  $Z_0 = 50 \Omega$ .
- B.  $C_L$  includes probe and jig capacitance.



TYPICAL CHARACTERISTICS

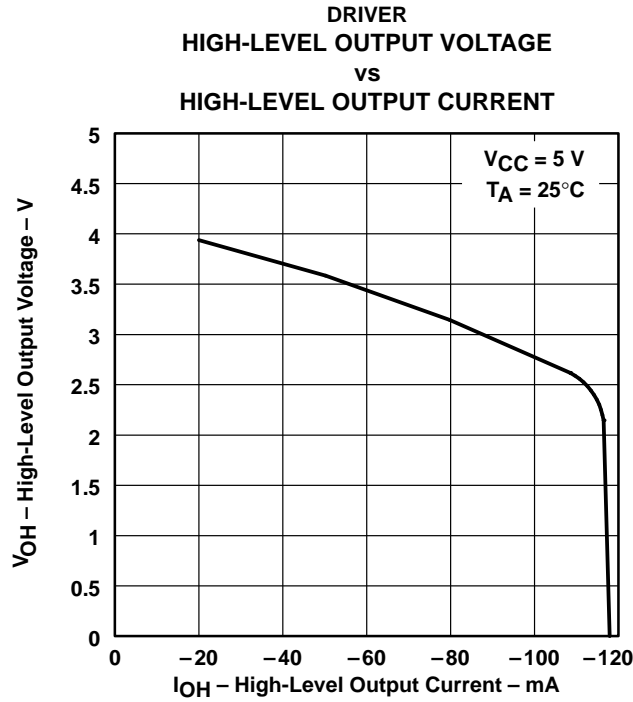


Figure 8

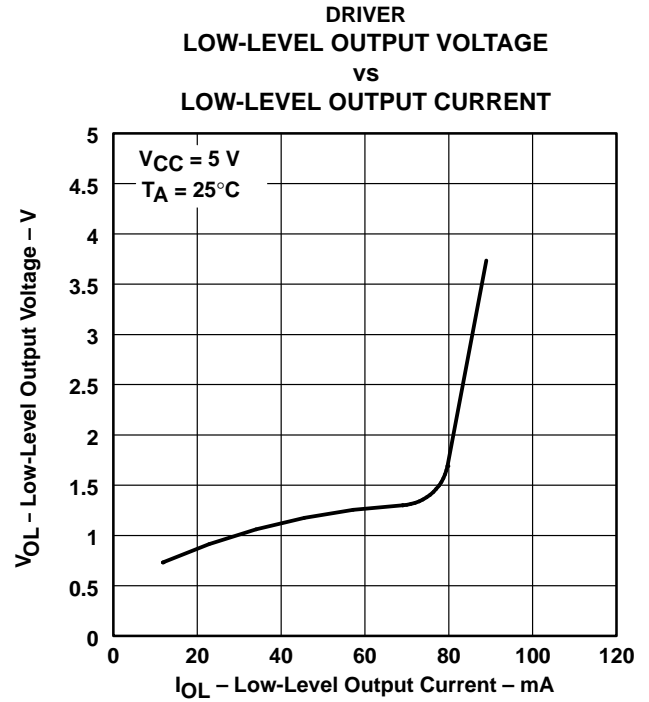


Figure 9

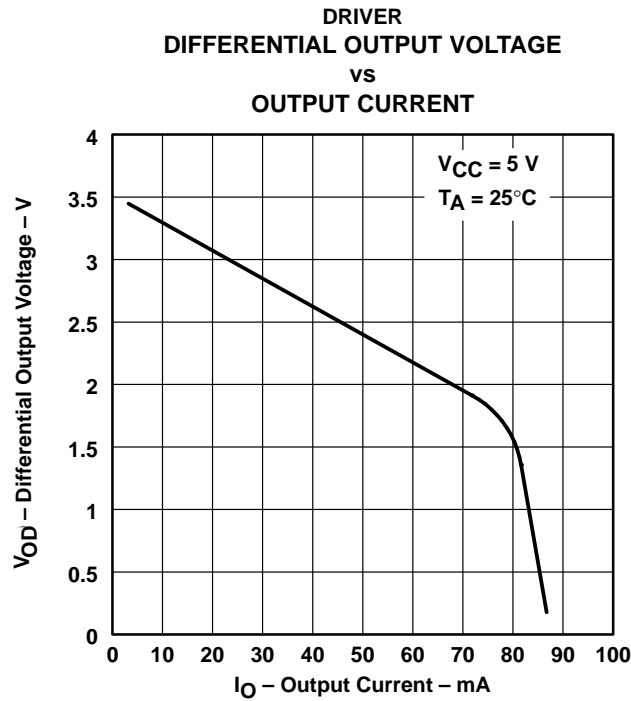


Figure 10

# SN65176B, SN75176B DIFFERENTIAL BUS TRANSCEIVERS

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## TYPICAL CHARACTERISTICS

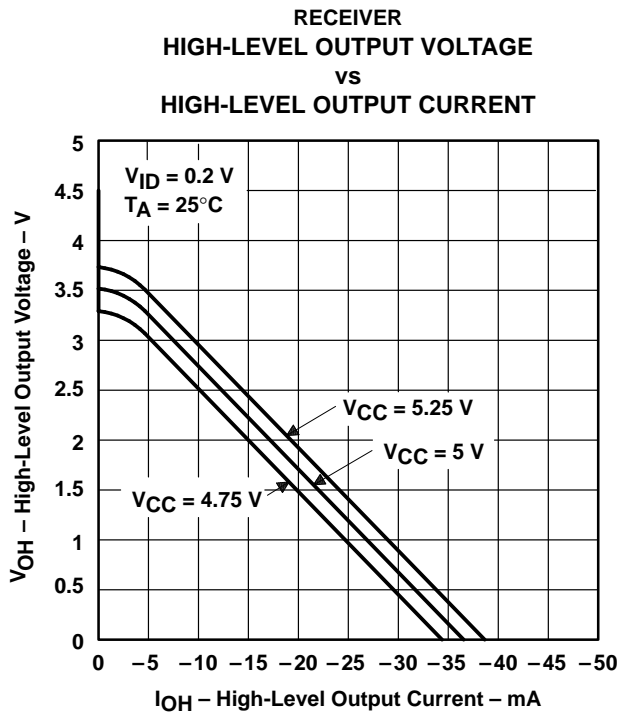
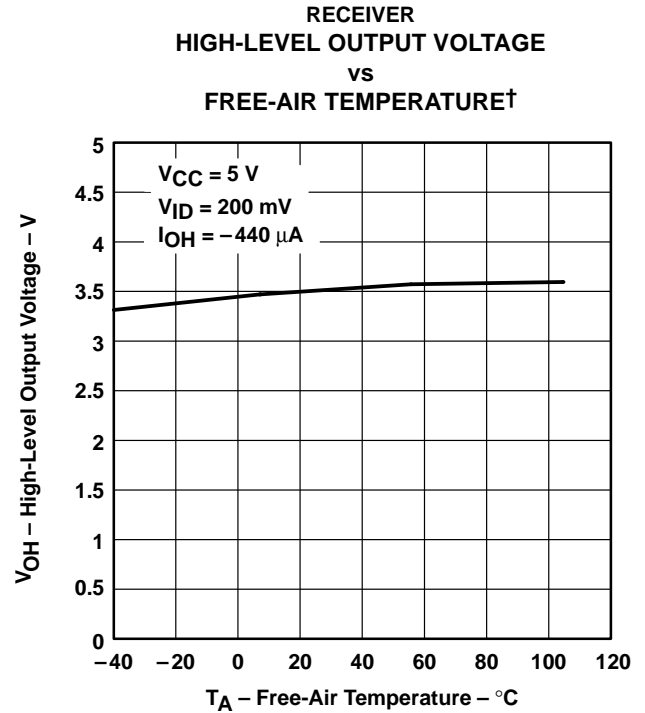


Figure 11



† Only the  $0^\circ\text{C}$  to  $70^\circ\text{C}$  portion of the curve applies to the SN75176B.

Figure 12

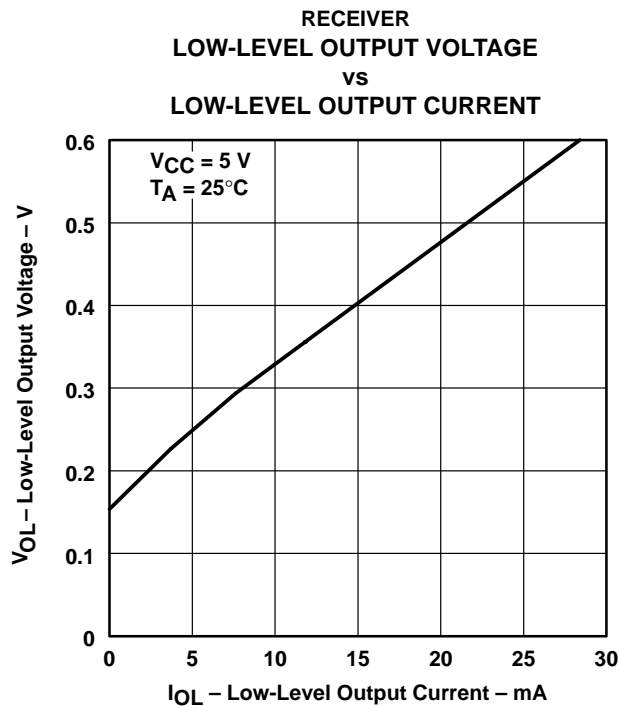


Figure 13

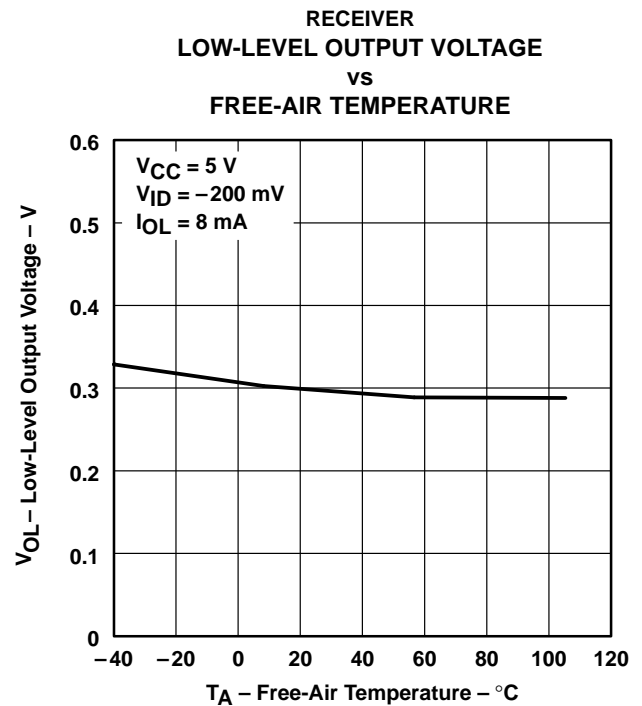
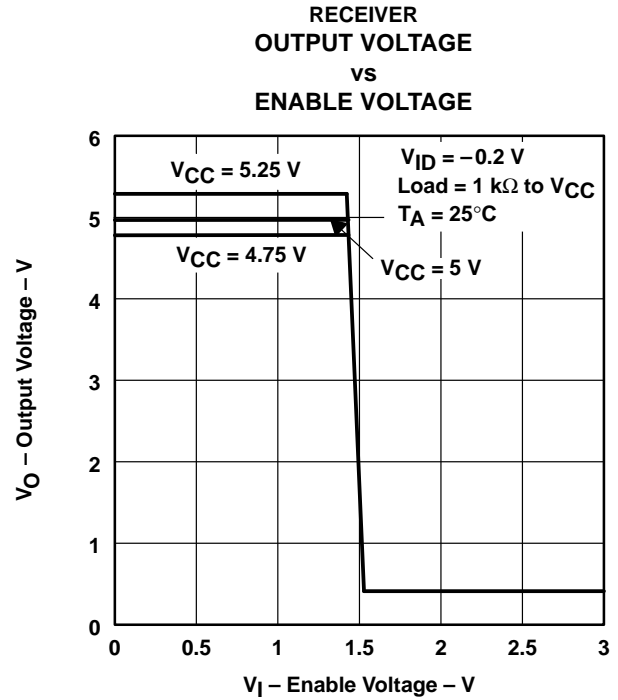
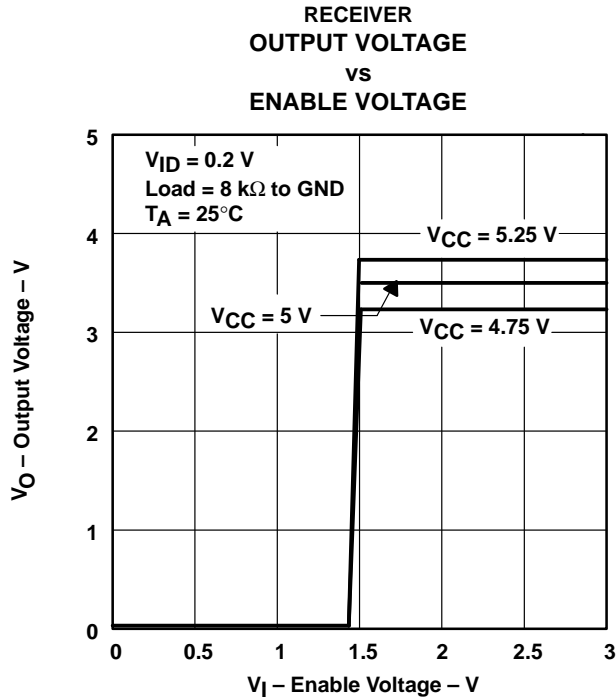
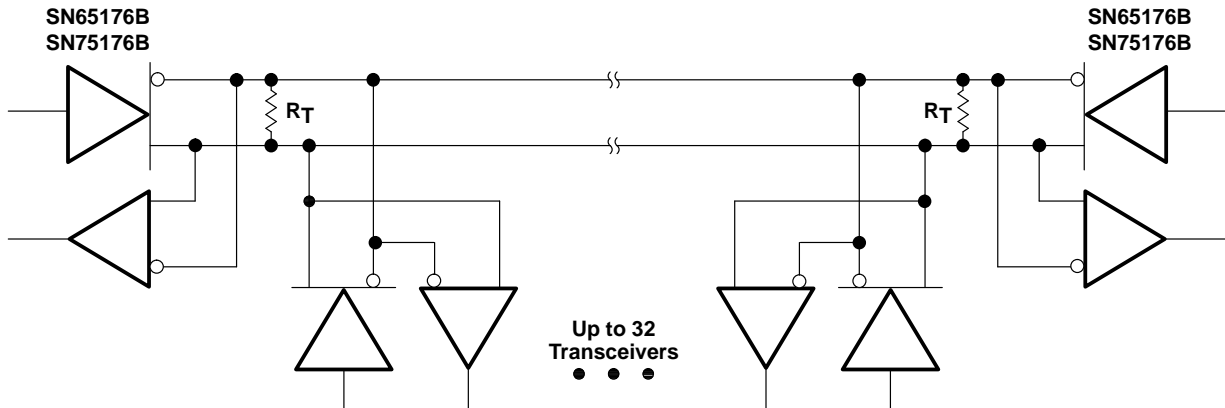


Figure 14

## TYPICAL CHARACTERISTICS



## APPLICATION INFORMATION



**Figure 17. Typical Application Circuit**

NOTE: The line should be terminated at both ends in its characteristic impedance ( $R_T = Z_0$ ). Stub lengths off the main line should be kept as short as possible.



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